ADVANCED MACHINING TOWARDS IMPROVED MACHINABILITY OF DIFFICULT-TO-CUT MATERIALS

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Tel: +603-6188 1542 / 44 / 45 Fax: +603-6188 1543
EMAIL: iiumprinting@yahoo.com

List of Contents

Chapter 5

Tool Wear and Surface Roughness Aspects in Heat Assisted End Milling of AISI D2 Hardened Steel

A.K.M. Nurul Amin[1*], M.A. Lajis[2], A.N. Mustafizul Karim[3]
[1,3]Faculty of Engineering- International Islamic University Malaysia
[2]Faculty of Mechanical and Manufacturing Engineering – UTHM, Malaysia
e-mail address of corresponding author: akamin@iium.edu.my

1.0 INTRODUCTION

With the advent of several advanced difficult-to-cut materials, and with the availability of heat resistant tool materials has posed a great challenge in industries. Hardened steel is one of these difficult-to-cut materials. During the last few decades numerous studies have been conducted to improve the machinability of these materials and many large organizations have invested considerably in exploring and developing new techniques to minimize machining costs of these materials while maintaining their quality requirements. The benefits for the manufacture of components from hardened steel are substantial in terms of reduced machining costs and lead times, in comparison to the more traditional route which involves machining in the annealed state, heat treatment, grinding or electrical discharge machining (EDM), and manual finishing [1]. Recent advances in cutting tool and machine tool technologies have opened up new opportunities for investigation in machining hard materials and especially for bulk removal of material. For these reasons the growing interest for hot machining process is being developed in industry. In this method work-piece is softened by heating and thereby shear strength is reduced [2]. The technology of hot machining is not new. Previous generations of this technology employed low-grade heat sources such as flame, electrical resistance, induction and plasma arcs [3]. Ozler et al. [4] integrated plasma gas heating in turning of austenitic manganese steel and he noticed that tool life increases when heating temperatures increased.

Preheating of workpiece by induction heating has been recently reported to enhance the machinability of materials. The latest current work done by Amin et al [5] when he carried out preheated induction heating in end milling of AISI D2 hardened steel using Poly Crystalline Cubic Boron Nitride (PCBN) inserts. He observed that preheated machining of the material leads to surface roughness values well below 0.4 μm, such that the operations of grinding as well as polishing can be avoided at the higher cutting speeds. He added that preheated machining has been able to reduce the amplitude of the lower frequency mode of chatter by almost 4.5 times at the cutting speed of 50 m/min. The primary causes of this stable cutting need to be studied in the perspective of material properties and damping capability of the material in the preheated condition. The primary objective of preheating is to enhance the ductility of the material for easier chip formation and better chip flow over the rake surface of the tool. In addition preheating is expected to improve the tool life and improve surface finish of the machined